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On the regional superparametrization of OpenIFS by 3D LES models

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We present the superparametrization (SP) of the ECMWF weather forecast model OpenIFS, by three-dimensional, high-resolution, large eddy simulations. Within a selected region, our setup replaces the global model parametrizations of boundary layer turbulence, cloud physics and convection processes with tendencies derived from the vertical profiles of instances of the Dutch Atmospheric Large Eddy Simulation (DALES). Vice versa, these LES models are being forced towards the corresponding local vertical profiles of the global model. We consistently combine the sequential physics scheme of OpenIFS with the Grabowski SP scheme and achieve concurrent execution of the independent DALES models on separate CPU's. The superparametrized region can be chosen to match the available compute resources, and we have implemented mean-state acceleration to speed up the LES time stepping. The coupling of the components has been implemented in a Python software layer using the OMUSE multi-scale physics framework. As a result, our setup yields a cloud-resolving NWP model that displays emergent mesoscale cloud organization and has the potential to improve the representation of clouds and convection processes in OpenIFS. It allows us to study the interaction of boundary layer physics with the large scale dynamics, to assess cloud and convection parametrization in the ECMWF model and eventually to improve our understanding of cloud feedback in climate models.